Insight

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Glossary

Illumination Conscious realization of how to solve a problem or how to understand the problem properly; usually quite sudden and emotional.
Incubation A stage of problem solving during which the conscious mind does not work on the problem; used to be accounted for in terms of implicit processing.
Problem A situation characterized by one's inability to find a way between the initial states of affairs (i.e., data) and the desired state of affairs (i.e., goal, solution); one knows what is needed but does not know how to get it.
Problem representation The way people understand the main features of the problem, particularly what the difficulty comes from, and what the obstacles are to achieve the goal.
Restructuring Conversion of the previous problem representation into a new one.

Insight is a sudden realization of the essence of a complex, paradoxical, or not well-understood situation, particularly the essence of a problem at hand. Insight is not synonymous with working out a solution to the problem; rather, it consists in understanding the gist of the problem through discovering its hidden structure. In problem solving, insight usually occurs after the preparatory stage, often following an 'incubational break,' and results in deep understanding why the problem is 'problematic.' In other words, insight produces realization of what the difficulty comes from, what the obstacles are to a good solution, and why the previous attempts to solve the problem were futile. Insights like that may be false and misleading, if based on inappropriate or incomplete data, but nevertheless they produce the unique (sometimes deceptive) feeling of understanding the essence of the problem. Besides problem solving, insight occurs in learning, where it produces deep understanding of a difficult subject matter, and in reception of creativity, where it leads to the realization of what is the message of the creative artwork. A particular example of insightful reception of one's creativity is the act of understanding a joke. According to Arthur Koestler, every act of creation includes an element of beauty (ah!), an element of wisdom (aha!), and an element of humor (haha!). Although in particular cases these elements occur in specific proportions, it is always possible to investigate production and understanding of humor instead of studying the whole creativity. Analogically, it is possible to examine insightful problem solving in laboratory settings, with the use of relatively simple tasks, to replace studying deep insights in science or technology, providing that such simple tasks are good models of serious and difficult problems taking place in mature creativity.

The Nature of Insight

The Gestalt psychologists introduced the term insight at the beginning of the twentieth century. It was put forward in opposition to the trial-and-error account of learning and problem solving, a stance advocated by the behaviorists. According to Wolfgang Köhler, Kurt Koffka, and Max Wertheimer, problem solving should not be described as a process of incremental increase of habit strength because people (and great apes as well) sometimes work on problems that are impossible to solve through continuous acquisition of learned skills. Such problems supposedly require fundamental change in the way they are perceived. Restructuring of problem perception occurs on the basis of already acquired knowledge but requires additional new elements and – this is particularly important – new arrangement of these elements. The problem before the solution is a 'bad' (i.e., incomplete or inelegant) figure, whereas after the solution it becomes a 'good' figure. In other words, problem solving is a process of conversion of a 'bad' figure into a 'good' figure through adding some lacking elements, along with rearrangement of all the elements of the problem (both 'old' and 'new') into a plausible structure.

Max Wertheimer described a little girl who was taught to estimate the area of a rectangle by counting the number of small squares into which the rectangle was divided. This counting-the-squares method was pretty successful in every instance of a rectangle but appeared inadequate in the case of a parallelogram. The girl was unable to find the area of a parallelogram until she realized a new possibility. She asked for scissors, immediately cut off the triangular part of the parallelogram, and put at the appropriate place on the other side of the figure. In this way, she obtained a rectangle, whose area was easy to estimate with the already acquired method of square counting. This example epitomizes all-important aspects of insight: The 'old' solution does not work anymore. The impasse is therefore inevitable. After some break, a new solution appears, which is quite unexpected. The new solution consists in the use of old knowledge completed with new elements. And, most importantly, the new solution is based on the essential change of the problem perception.

Laboratory studies of insight cannot rely on realistic difficult tasks, like scientific problems; therefore, some relatively simple but tricky tasks are usually explored. For instance, a task may consist in deciphering the meaning of an expression, such as 'poPPd.' The expected answer to this rebus, 'two peas in a pod,' requires not only perfect knowledge of idiomatic English but also specific mindset and – maybe – an ability to read the intentions of the experimenter. Insight tasks may be nonverbal as well, such as a series of various 'matchstick problems.' For example, a person may be asked to compose four unilateral triangles out of six matchsticks; the solution seems impossible until one realizes that he/she is supposed to build a pyramid. Or, a person may be asked to convert an equation expressed in Roman numerals, for example, IV = III – I, into the correct version using just one stick, that is, IV – III = I. Such tasks, though appealing to one's mental flexibility and the ability to overcome fixed mindsets, require some specific skills, like spatial imagination (pyramid) or knowledge of Roman numerals (equation). If so many factors count, validity (i.e., what is actually measured) and reliability (i.e., how well is it measured) of such tasks appears as serious methodological issues.

Stellan Ohlsson introduced a task that proved to be quite popular and useful in the studies on insight (Figure 1). It is a much more advanced and difficult version of the problem that was solved by the little girl, described by Max Wertheimer. The task is to find the sum of the areas of square ABCD and parallelogram EBGD, given that AB = a, and AG = b. We know very well that the area of a square is obtained by multiplication of the length of its two edges, which is easy. We also may remember that the area of a parallelogram is obtained through multiplication of the length of its base by the length of its height, but the latter value is not provided (the former is possible to deduce). However, the solution is immediately worked out as soon as one realizes that the needed sum of areas is obtained through moving the triangle DCE upwards (or the triangle ABG downwards), so as to compose two big triangles, and eventually one big rectangle, whose square is easily computed as a times b. Although this task requires basic mathematics, its difficulty results from the necessity in perceiving it in a new and unconventional way rather than from complex mathematical reasoning.

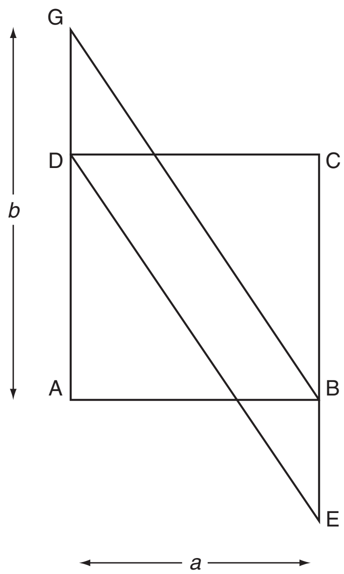

Figure 1 Given that the line AB = a and the line AG = b, find the sum of areas of square ABCD and parallelogram EBGD (Ohlsson, 1984).

The Features of Insight

Suddenness

Insight is usually experienced as sudden and unexpected. Eminent creators, on the basis of their introspective analyses of the creative processes, often report these feelings. Introspection lacks objectivity, but if the phenomena under consideration are subjective by nature, it must not be ignored as a source of relevant data. The empirical psychology argues that similar phenomena take place in controlled experimental settings, too. Psychologists also try to answer the question why insight is experienced as sudden and unpredictable.

Investigations on suddenness are based on the technique called 'feeling of knowing.' People are presented with an intellectual problem and asked to judge their subjective feeling of being close to the solution. They may use a 1–10 point scale where '1' means 'I'm at the starting point' and '10' means, 'I know how to solve it.' It usually appears that this subjective feeling of knowing rises only 10–20 seconds before emergence of the actual solution. People are quite unable to discern any symptoms of the upcoming solution during the earlier stages of the process of thinking. It also appears that the feeling of knowing may rise quite evenly in the case of regular algebraic problems but not in the case of insight problems. The latter usually produce irregular curves of changes of the feeling of knowing (i.e., with many ups and downs). If the problem solver is eventually successful, the curve rises steeply during a few final judgments but not earlier. This pattern of relationships suggests that insightful problem solving typically results in a solution that is unpredictable for the problem solver, and the process of looking for solution is interpreted as 'catastrophic' or lacking continuity.

Malcolm Westcott demonstrated the phenomenon of discontinuity in the studies on 'intuitive leaps.' Participants were presented with a series of numbers ordered according to some principle, for example, 4–5–3–6–2–7–1–?. Their task was to decide which number is supposed to replace the question mark if the underlying principle is valid. Some people were ready to make a decision only after two or three elements of the series, whereas others needed more time for that. The former apparently made their choices on the basis of quick, spontaneous speculations, rather than elaborated deductions. In follow-up studies participants were encouraged to guess the elements of series as soon as possible. It appeared that those who were inclined to make such 'leaps' scored higher on the independently administered battery of insight problems. Therefore, such 'intuitive leaps' may be interpreted not only as an illustration of discontinuity in problem solving but also as a model of intuitive processes in high-level creativity.

Where does the subjective feeling of suddenness of insight comes from? According to Graham Wallas, the author of the 'theory of incubation,' suddenness of insight results from the unconscious nature of creative processes. If a creative idea is 'incubated' in the unconscious parts of the mind, its eventual appearance must be unpredictable and entirely unexpected for the consciousness. This theory, although very popular and influential, was questioned by the proponents of the so-called 'nothing special' approach. According to Robert Weisberg, creative processes do not differ in kind from less creative functions of the mind. Particularly, they have nothing to do with unconscious 'incubation,' because they rely on the incremental process of accumulation of knowledge. The creative process supposedly consists of consecutive trial and errors, being usually very long, full of pauses, and tiresome. If a particular trial appears successful, a person may have an impression of unexpectedness of the creative idea. But this is just an illusion, coming from large number of previous unproductive attempts.

Incubational Break

Even though the theory of unconscious incubation is questioned for a lack of empirical evidence, there are good reasons to ask about possible benefits of breaks in the creative process. The occurrence of such breaks is unquestionable. For instance, Catherine Patrick observed painters during their work and concluded that the process of drawing a picture is discontinuous in nature. The artists usually start with an initial idea, which is seemingly abandoned and replaced by alternative options. However, the original idea tends to reappear from time to time, and the whole process of creation makes the impression of being abundant with breaks and pauses.

Five hypotheses have been formulated to explain the effect of incubational break.

1. The hypothesis of unconscious activity of the mind, although formulated more than 100 years ago, still has its proponents. If this stance makes any sense, an incubational break must be long enough in order to allow the unconscious mind to work out a tenable solution.
2. It is claimed that a break allows renewal of energetic resources because creative work may be prolonged and exhaustive (so-called 'fatigue-dissipation hypothesis'). This viewpoint is somewhat opposite to the unconscious thinking hypothesis, as it amounts to the conclusion that nothing particular happens during the break.
3. A break supposedly allows redirection of attention from futile ideas and misleading aspects of the problem perception to some new and more promising pieces of information. According to this explanation, people must change their activity during the break, possibly to something completely unrelated to the original problem, because otherwise the effect of attention redirection cannot be obtained.
4. A break probably leads to elimination of ineffective mindsets, false assumptions, and other symptoms of mental rigidity. If this hypothesis makes sense, it should not be important what type of activity takes places during the incubational break because its beneficial effects result from mere flow of time.
5. It is claimed that something particular must happen during the break, namely, a new piece of information is perceived which serves as a source of inspiration and therefore leads to a new and productive idea. For instance, a person reads relevant literature or discusses the problem with other people, and thanks to such events, assimilates new and productive pieces of knowledge. Sometimes the process of assimilation is subtle enough to prevent any conscious realization of the actual sources of inspiration. For instance, a person perceives an analogical solution in some area that is distant and seemingly irrelevant to their problem. In such cases, inspiration works without conscious realization of the source of a new idea, although one's mind must be prepared for assimilation of relevant information.

Some of the above-sketched hypotheses have been verified experimentally. For instance, Roy Dreistadt demonstrated that short (eight minute) incubational breaks alone did not improve performance on an insight problem solving test but helped to assimilate pictorial analogies that were dispersed in the lab and served as 'hints' to the participants. People who saw these hints but had no opportunity to take a break obtained lower scores. These results favor the fifth hypothesis, according to which the break does not work as such but serves as an opportunity to assimilate some new relevant information. More recently, Eliaz Segal asked students participating in his study to solve the problem of the parallelogram (Figure 1). Participants were given a short (four minute) or a long (12 minute) break, during which they solved crosswords (a demanding activity) or leafed through newspapers (a nondemanding activity). There was also a group with no break allowed. It appeared that the break resulted in increased proportion of correct answers but its duration did not matter. It was also demonstrated that the demanding activity during the break was more beneficial than the less demanding one. It is therefore possible to conclude that:

1. incubational breaks work;
2. the unconscious activity of mind probably does not take place (duration of breaks is irrelevant); and
3. breaks allow redirection of attention from irrelevant aspects of the problem to the relevant ones (demanding activity is beneficial).

Restructuring

The notion of restructuring is crucially important for the original Gestalt account of insight. However, the Gestalt psychologists did not develop any mature theory of restructuring, sometimes over-relying on metaphors like 'replacement of figure with background' or 'seeing the problem from another perspective.' More elaborated models of restructuring have been worked out by cognitive psychologists and cognitive scientists in the last three decades.

According to Stellan Ohlsson, people typically attempt to solve problems through retrieving relevant knowledge from their long-term memory, while elements of the mental representation of the problem serve as retrieval cues. In 'normal problem solving' such a strategy may turn out to be successful but if a problem is tricky or unusual, a person runs into an impasse. In order to break the impasse, a person needs to restructure their mental representation of the problem. Instead of trying to find a way between the initial state of affairs (i.e., the problem) and the attempted goal state (i.e., a solution), one aims at constructing a new problem space, where both the initial state and the goal state are either changed substantially or replaced by entirely new structures. In consequence, restructuring means that a new problem arises in one's mind, with new initial data, new goals, and new constraints. When such a change is completed, the transformed mental representation of the problem works as a fresh source of retrieval cues, thanks to which some relevant data, already stored in the long-term memory, can be used in a productive way.

Ohlsson improved the Gestalt theory through identifying three separate types of restructuring: elaboration, reencoding, and constraint relaxation. Elaboration consists in adding new elements to the original mental representation, so as to make it complete. For instance, the problem of the parallelogram (Figure 1) is easily solved if one adds new elements to its original representation, namely, two big triangles ABG and DCE. The original representation involves the square and the parallelogram, whereas the transformed representation consists of just two triangles. Reencoding amounts to sticking a new label to some old elements of the problem, which usually require that these elements be included into another category. For example, the rebus 'poPPd' ('two peas in a pod') is solved only if one includes two capital letters (PP) into one category, and three lowercase letters (pod) into another category. In other words, the solution requires that the already encoded elements be encoded again in this entirely new way, because particular letters must be treated as independent words instead of parts of words. The third mechanism, constraints relaxation, consists in abandoning, or at least lessening, some impediments, rules, or obstacles that previously seemed unconditional. For example, if the task is to compose four unilateral triangles with the use of six matchsticks, one has to abandon the tacit and false assumption that all triangles must be located on the same plane. Only after such relaxation is accomplished, one is able to build a pyramid of six matchsticks.

The Cognitive Mechanisms of Insight

Selectivity

Janet Davidson and Robert J. Sternberg proposed the selectivity theory of insight. According to the authors, insightful problem solving does not differ in kind from 'regular problem solving.' What makes a difference amounts to selectivity with which otherwise regular mental processes are executed. There are three types of selectivity that the authors believe are important for insight: selective encoding, selective comparison, and selective combination.

Selective encoding consists in taking into account some pieces of information that, though present in the perceptual field, were hitherto ignored as irrelevant. Alternatively, selective encoding may consist in ignoring some elements of the problem as irrelevant, although they tended to be treated as rather important. These two aspects of selectivity take place mostly in perception but may also occur in remembering and concept formation. Louis Pasteur's discovery is a good example of selective encoding. Pasteur noticed that grapes with broken skin quickly staled, whereas grapes with whole skin preserved their freshness for a long time. These facts were well known to everyone but only Pasteur understood that broken skin is a gateway open for microbes. In consequence, he was able to formulate the germ theory of fermentation.

Selective comparison amounts to discovery of relations between new facts and previously acquired pieces of knowledge. Thanks to such comparisons people can achieve new solutions through analogical transfer of knowledge. They use already acquired knowledge to work out novel ideas, which are 'borrowed' from other schemas, or even other domains. Davidson and Sternberg illustrated this phenomenon with an anecdote about Archimedes, who had to find out if the king's crown was made of genuine gold. He knew the specific weight of gold but was unable to determine the irregular crown's volume. Fortunately, he noticed that the human body, which is also irregular in shape, elevated water if sunk in a bathtub. As soon as he discerned the analogy between the irregular human body and the irregular crown, he knew the solution: immerse the crown into water, measure the volume of water pressed up by the crown, which is equal to the volume of the crown, calculate the expected weight of the crown if it was gold, and – finally – compare the expected and the actual weight of the crown. Although anecdotal, this story epitomizes numerous examples of analogical transfer in science and technology.

Selective combination is a process through which people connect dispersed, seemingly unrelated pieces of knowledge into sensible, meaningful structures. Construction of scientific theories often matches this pattern. For example, Charles Darwin sketched the theory of evolution through connecting numerous facts from botany, paleontology, ornithology, and other domains of natural sciences. He provided an explanatory pattern thanks to which all these facts appeared understandable and meaningful. Sometimes selective combination leads to transformation of the old theory rather than construction of a new one but in every case this process requires that seemingly unconnected facts and observations be composed into a new and elegant configuration.

Simplification

Creativity is often impeded by the fact that problems that require new and productive approaches are incredibly complex in nature. The amount of data that have to be taken into account in order to construct a cognitive representation of the problem may give the impression of being too large for the human mind, particularly in science and technology but also in some domains of artistic creativity. Great creators undoubtedly possess enormous cognitive skills but nevertheless the complexity of problems they have to deal with does not seem compatible with the capabilities of any human mind. The disparity between what has to be done and human mental capabilities seems particularly severe in reference to working memory. This module is specialized in current information processing, so-called mental combinatorics, and it is severely limited in capacity. It is estimated that working memory can keep only about four separate chunks of information simultaneously. Four pieces of information may not be enough for economical shopping, not to mention insightful problem solving.

Herbert Simon was aware of the problem of disparity; therefore, he developed a theory of scientific insight whose main message amounts to the thesis that scientific problems must be substantially simplified in order to be solvable at all. Simplification is possible thanks to two independent processes: familiarization and selective forgetting. Familiarization is a long process of getting acquainted with all-important aspects of the problem. The situation is analyzed from many different perspectives. Also, many different ideas emerge how to solve the problem, but all of them turn up to be false or incomplete. During this lengthy and 'intimate' contact with the problem, its structure is constantly changing. In particular, a person is able to perceive the problem from a very high level of abstraction, or – if necessary – with subtlety typical of perception at the lowest possible level of abstraction. In other words, the problem may look either simple or complicated, depending on the level of abstraction. In addition, during familiarization the elements of the problem are packed into 'mental parcels,' that is, they are composed in chunks defined on the basis of either content or association with other elements. In consequence, the problem gets more and more simplified although it is not deprived of important, building elements.

Simultaneously, selective forgetting allows the disposal of those elements of the problem that are not important, or even misleading. In every scientific problem, there are many pieces of data that are superfluous, redundant, or meaningless. It would be very advisable to get rid of them as soon as possible, if only one could tell which elements are actually misleading. Fortunately, the long process of deliberation about the problem makes such decisions easier, because what seems important at the beginning may lose importance later on, and *vice versa*. The mechanism of selective forgetting is especially beneficial from this point of view because it eliminates unnecessary elements of the problem quite automatically. We just do not remember some pieces of knowledge anymore, so we do not have to decide at the conscious level what is relevant and what is not.

Familiarization and selective forgetting may take a very long time but as soon as the problem is simplified enough, the solution appears as if unexpectedly. According to Herbert Simon's theory, unexpectedness is just a side effect of simplification of the problem structure, which is possible thanks to two independent but mutually supportive processes: familiarization and selective forgetting.

Assimilation

Assimilation is a process through which new elements are introduced into the cognitive representation of the problem. New pieces of knowledge are absorbed from the environment thanks to the ability of the properly prepared mind to exploit helpful external cues.

Colleen Seifert and her colleagues proposed a theory of insight based on the notion of opportunistic assimilation. According to this stance, the creative process starts with 'confrontation with the problem,' that is, with numerous attempts to understand the problem and to find a plausible solution. Striving for a new and valuable outcome is likely to result in a number of failed attempts so any serious creative work requires long-term commitment and strong motivation. When the impasse occurs, the human mind uses so-called failure indices in order to mark components of the unsolved problem in the long-term memory store. Thanks to these failure indices, the human mind remembers its fiascoes: it is quite easy to remember that one was not successful and to retrieve required elements of the unsolved problem. The failure indices make one's mind rather vigilant, or 'hyper attentive,' to pieces of information that might be helpful in working out a solution.

The confrontation with the problem, the following impasse, and setting up failure indices, supposedly take place in the preparation phase of creativity. Then, the incubation period follows, which is characterized by a lack of any observable problem solving activity. This phase is very important, though, not because of hypothetical unconscious mental activity but because of increased tendency of the well-prepared mind to absorb relevant data from the environment. Siefert et al. do not agree with Simon's hypothesis about selective forgetting, nor with the argument that an incubational break alone is sufficient for success. Rather, they argue that the previously prepared mind is very sensitive to those elements of external stimulation that may be a source of relevant information. The mind takes a chance provided by the environment. External cues appear accidentally but their being utilized is the effect of the formerly performed job of confrontation with the problem, establishing failure indices, and making the mind well prepared for taking an opportunity to exploit relevant environmental cues. The experience of illumination, being a culmination of the creative process, results from unexpected 'opportunistic assimilation' of external cues that happen to be crucially important for finding a solution to the previously unsolved problem.

Conclusions

Insight is undoubtedly a pivotal moment of the creative process, so understanding insight results in better understanding creativity. The scientific study of insight brought about interesting theories, as well as valuable empirical evidence. However, there seems to exist a serious disparity between real-life insights, for example, in science and technology, and so-called insight tasks widely employed in laboratory studies. Future advances in the theory of insight seem to depend on the researchers' ability to unify the experimental laboratory studies with *in vivo* observation of genuine creative processes.

See also: Remote Associates; Max Wertheimer 1880–1943.

Further Reading

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Relevant Website

http://en.wikipedia.org/wiki/Insight – Insight wiki.